Policies for a Sustainable Energy System in the US

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Innehåll

Summary

US energy policy aims at achieving a secure, affordable and clean energy supply.

Energy security, low energy prices and the goal of diminishing US dependence on imported oil has been at the front of energy policy for decades, but the recent development in the unconventional oil and gas sector has breathed new life in the quest for independence, and increased domestic energy production has sparked a new outlook for the energy sector with repercussions for industry, growth and global security.

At the same time US energy policy is also striving towards clean energy and environmental protection, in particular as regards the climate. Although climate change is still a debated and divisive issue it is again being put at the forefront by President Obama, who presented a new climate strategy earlier this year. Existing legislation, in particular the Clean Air Act, is used to address carbon emissions from coal fired electricity generation, vehicle fuel economy standards and energy efficiency standards for appliances and industry are put in place or tightened and the federal level spends substantial amounts on R&D and subsidies for renewables.

And renewable energy, in particular wind and solar energy have indeed increased fast over the last years, aided by continually lowered costs, states' renewable portfolio standards and federal subsidies, in particular the Production Tax Credit (PTC); and the President has set the goal of doubling renewable energy again till 2020.

Notwithstanding this, however, renewables remain at a fairly low aggregated level and fossils and nuclear energy will according to most scenarios (both public ones and from industry – not the least important since energy is fundamentally market driven in US) continue to constitute a major part of the US energy supply by 2040. The future for the PTC is uncertain in the present budgetary situation. The move to regulate carbon emissions from power plants may be contested and it is uncertain whether the new regulations per se will lead to significant emissions reductions. And earlier criticized for not putting enough focus on oil and gas production, the President now adheres to what is termed an "All of the above" energy strategy, meaning that all domestic energy sources, including clean coal, oil, gas, nuclear and renewables are supported and embraced.

The present long term energy scenarios mean that it will be tough for the US to meet long term climate targets. One obvious challenge, that is not really dealt with by the administration, is how to balance the influx of low priced gas and the associated build out of gas power infrastructure with a long term climate scenario, in other words how to make it possible not only to get on natural gas as a bridging solution, but also to get off the bridge. Shrinking room for federal R&D budgets and other costly policy measures is another.

While the US currently lacks both comprehensive climate legislation and a fully-fledged energy policy at the federal level (the latest, substantial energy acts were passed in Congress in 2005 and 2007) , the Department of Energy Quadrennial Technology Review, for example, has identified the strategies of *increasing vehicle efficiency*, *electrification of the vehicle fleet*, *deployment of alternative hydrocarbon fuels, increasing building and industrial efficiency*, *modernizing the grid*, and *deploying clean electricity* as central for delivering energy policy. A new take on integrated energy policy will be done through the upcoming Quadrennial Energy Review.

In terms of the outlook for individual energy sectors, the effects of the natural gas development is a recurring theme. Low priced natural gas not only to an extent replaces coal for new electricity production and constitutes a formidable competition for renewables, nuclear and other power generation, it also increasingly considered for other than the traditional industry and heating uses, in particular for the transport sector, even though this is so far restricted by high infrastructure costs.

The coal industry foresees a bleak outlook with little new plant construction, but the sector will still provide substantial parts of electricity in the decades to come. Even though earlier hopes of commercial CCS by 2020 have largely been stifled, a limited number of pilot and commercial scale CCS in industrial and power plant applications are coming online, often with enhanced oil recovery as an income enhancing ingredient. In the absence of a substantial price on carbon or a comprehensive regulatory regime a broad roll out of CCS is unlikely in the short to medium term.

After a long time with very limited new build of nuclear energy plants, four new reactors are now under production. High capital costs and the competition of low priced natural gas limits the outlook for further expansion, but continuing upgrades and possible life-span extension mean that the nuclear fleet will keep up its generation capacity over the medium to long term. The potential for small, modular reactors is probed as a new option. Waste disposal is an unresolved issue.

Increased domestic oil production and higher vehicle efficiency among other factors have somewhat diminished the demand for imported oil. To tackle long term oil dependence in the transport sector the US simultaneously supports the development of biofuels and electrification of vehicles. The renewable fuel standard has led to a large production of corn based ethanol, and to some extent biodiesel. Since fuel volumes are not increasing in the way envisioned when the law was created the EPA has recently decided to scale down the volume ethanol that the industry must blend over the next years. R&D for second generation biofuels get substantial federal support and new large scale factories are being commissioned but the industry still awaits breakthroughs to make biofuels cost efficient. The same can be said for the E-Vehicle sector, where the Obama administration puts in a lot of support for developing battery and vehicle solutions and domestic manufacturing to reap benefits in terms of industry jobs and exports. Oil consumption is projected to be more or less flat in the outlook to 2040.

Energy efficiency is recognized as an important way to achieve energy security and climate goals, but also to create jobs and save costs for consumers and industry. The setting of efficiency standards and support for energy efficiency R&D are two ways the administration works with the issue.

Energy policy is guided by a complex mix of legislation, regulations, subsidies and other instruments at both the federal and state levels. At the federal level, the Environmental Protection Agency’s work on regulating greenhouse gas emissions using the Clean Air Act is an example of the current focus on regulations and standards, as are the Renewable Fuel Standard, the CAFE fuel efficiency standards and efficiency standards issued by the Department of Energy. R&D support for clean energy is another important tool at the federal level, as are different types of subsidies and tax incentives.

1 Energy strategies and overall outlook to 2040

The US energy policy goals can at an overarching level be summarized as striving to achieve secure, affordable and clean energy.

Energy security and diminished dependence on imported oil has been a mantra in US policy for decades; practically all presidents since Nixon have vowed to end dependence on foreign oil. Spiking gasoline prices at the pump due to increases in the cost of oil is a sensitive domestic issue and US engagement in world affairs has at least partly been linked to the need to secure safe global oil supplies. The US military, the world's largest oil consumer, is itself highly dependent on a reliable fuel supply.

Further, and notwithstanding the differing opinions in the US on the scientific underpinning for global warming and the partisan and the gridlock in congress on climate issues, reducing greenhouse gas emissions is also a central energy goal for the Obama administration, as it is for many states and local governments. During 2013 President Obama has taken a new grip on climate issues and the climate strategy earlier this year puts energy issues at the forefront. Secretary for Energy Moniz has stated that working with delivering the climate agenda will be (one of) the most important tasks for the Department of Energy, in cooperation with the Environmental Protection Agency and other agencies.

But as important is the urge to increase domestic energy production and secure low energy prices. The current shale gas and oil boom – supported by the administration - has stimulated the economy and given a fresh outlook for American industry, as well as breathed new life in the hope to lessen the dependence on imported fuels. It is a stated goal that the US wants to lead in innovation for a clean energy future and secure job creation by developing new energy industries at home and advance US manufacturing.

The President has defined an energy policy labeled as "all of the above", meaning that the US shall strive to develop *all* domestic energy sources, including nuclear energy and fossil fuels including oil, gas and even "clean" coal, apart from renewables and energy efficiency. A number of overarching policy goals have been put forward over the last few years by the President; these include reducing the overall oil dependency by more than 2 million barrels a day by 2025 and reducing oil imports by half by 2020, doubling renewable energy production from wind, solar and geothermal by 2020 and doubling energy productivity by 2030. 80 per cent of US electricity is to be derived from clean-energy sources by 2050. Obama's climate goals from 2009 are to reduce greenhouse gas emissions by 17 per cent by 2020 and 83 per cent by 2050, from a 2005 baseline.

At a more detailed level, the White House in 2011 presented a strategy for increased energy security, "*the Blueprint for a Secure Energy Future*"[1]. The Blueprint includes a long list of goals, targets and measures to, inter alia:

- "Expand safe and responsible domestic oil and natural gas development and production", including raising safety and efficiency in oil and gas exploration and identifying suitable sites for exploration
- "Lead the world towards safer, cleaner and more energy supplies", including the phasing out of fossil subsidies, expanding gas production globally, reducing methane emission, promoting bioenergy, e-vehicles and clean energy technologies
- "Provide consumers with choices to reduce costs and save energy", including fuel efficiency standards for the transport sector, advancing vehicle and battery technologies
- "Innovate our way to a clean energy future", including continuing and intensified R&D support, grid modernization, and more.

A report on progress on the Blueprint goals and actions was presented in 2012[2].

President Obama's Climate Action Plan[3] from June 2013 focuses on reducing carbon emissions, preparing for impacts of climate change and securing US leadership of international efforts to address climate change. It contains a range of executive government actions, many of which are directed at the energy sector. The single most important part of the plan for addressing carbon emissions concerns regulating carbon emissions from power plants through the Clean Air Act but it also contains a long range of other energy actions, including loan guarantees fossil energy and efficiency projects, permitting of renewable energy on public lands, a challenge to achieve more energy efficient buildings, fuel economy standards for heavy-duty vehicles and new energy efficiency standards for appliances, as well as targets for the federal government's own energy use.

The Blueprint and the Climate Plan are partly over-lapping and jointly present a picture of White House energy strategies.

At cabinet level the Department of Energy (DOE) holds the central role, even though several departments are also heavily engaged in energy issues.

In 2011 DOE produced its own strategic plan, which presents priorities for different technologies and fields of research and development as well as management and corporate governance principles. The strategy presents a number of actions fields for transforming the energy system, including: driving energy efficiency to reduce demand growth; demonstrating and deploying clean energy technologies; modernizing the electric grid; enabling development of natural (energy) resources; accelerating energy innovation through R&D; facilitating technology transfer to industry.

Following recommendations from the President's Council of Advisors on Science and Technology (PCAST, an independent advisory body within the White House) on ways to accelerate the migration to a low-carbon energy system, the DOE has performed a

[1] http://www.whitehouse.gov/sites/default/files/blueprint_secure_energy_future.pdf
[2] http://www.whitehouse.gov/sites/default/files/email-files/the_blueprint_for_a_secure_energy_future_oneyear_progress_report.pdf
[3] http://www.whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf

comprehensive review of its strategic options for energy system transformation towards the national goals. The review, called the Quadrennial Technology Review (QTR) is a precursor to an even broader energy systems review, the Quadrennial Energy Review, to be performed every four years jointly by all federal agencies with energy agendas.

The QTR presents aggregate, agency wide strategies as well as 17 individual technology assessments that describe current techno-economic aspects and R&D opportunities for the most important technologies or systems.

The QTR differentiates between energy challenges for the transport sector and the stationary/residential, commercial and industrial sectors and identifies six overarching strategies:

- Increase vehicle efficiency,
- Electrify the vehicle fleet,
- Deploy alternative hydrocarbon fuels,
- Increase building and industrial efficiency,
- Modernize the grid, and
- Deploy clean electricity

In sum, the overriding US energy goals are to achieve secure, affordable and clean energy. Climate protection is an important policy goal and the US wants to decrease greenhouse-gases from the energy sector significantly and migrate to a clean energy system. Hence the administration supports R&D and deployment of renewables as well as energy efficiency, but this goal does not override the need to secure affordable energy and the development and utilization of domestic energy sources remains important.

The overall outlook on different energy sources in the US can be illustrated by the projections from the federal Energy Information Agency (EIA), which makes independent energy forecast taking into account enacted legislation and other realized policy measures at the federal and state levels. The EIA 2013 Energy Outlook reference scenario for 2040 for example shows an increase from 8 to 11 per cent for in renewables in aggregate energy demand, and a doubling from 1 to 2 per cent for liquid biofuels but the renewable sector still only provides a fraction of aggregate demand. This scenario obviously represents only one possible future but it indicates the broad direction of US energy.

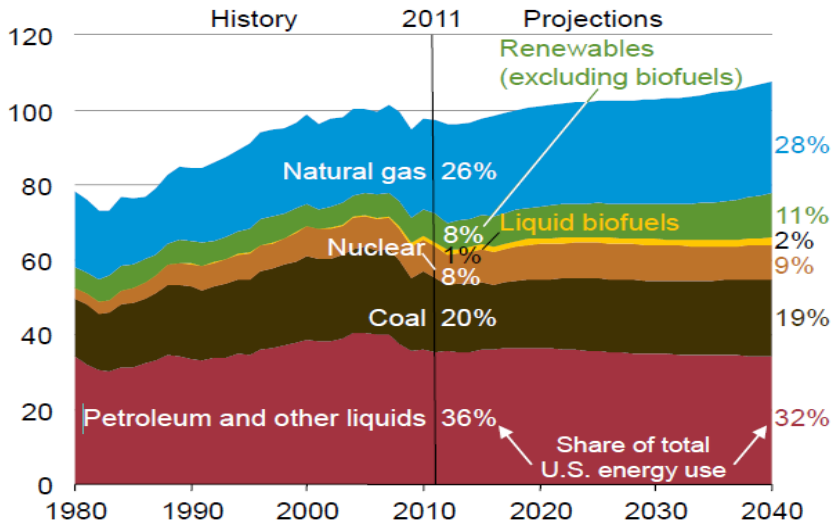

Figure 1 Primary energy use by fuel, 1980-2040 (quadrillion BTU)

Source: Annual Energy Outlook 2013, EIA

Under the following headings, the development and outlook for a number of different aspects of the US energy scene are presented. For a thorough description of the development for natural gas, the energy source that currently attracts the most interest along with renewables, a general description of the energy system and energy R&I system, see the Growth Analysis reports on US Energy, Shale Gas and Energy R&I from June 2013 and November 2013 respectively.

2 Outlook for individual energy sources

2.1 Coal

Even though renewable energy generation from wind and solar power has more than doubled over the last four years, coal and other fossil fuels still provide 80 per cent of US energy, with coal alone answering for approximately 20 per cent of all energy and 40 per cent of electricity generation. The US administration acknowledges that coal will be an important part of the energy future for electricity production over the next decades to come. The EIA reference scenario from April 2013 indicates that coal will still provide more than 35 per cent of the electricity in 2040. Moreover, the US holds the world's largest estimated recoverable reserves of coal and is a net exporter.

That said there is no question that coal is facing substantial challenges.

A number of these are of a regulatory nature. As a centerpiece of the Obama administration climate strategy[4] the EPA has pushed ahead with regulating carbon dioxide emissions from power plants based on the Clean Air Act[5]. Following a lengthy process EPA in September 2013 proposed final regulations for emissions CO2 from new power plants. The regulation that will take effect in 2014 limit emissions from new coal plants to 1100 pounds CO2 per MWh. In practice, this means that production of new coal plants will not be possible without adding CCS-technology. Natural gas plant CO2 emissions, on the other hand, are below the threshold and will not require CCS.

EPA has also started work on regulating CO2-emissions from existing power plants, a challenging task. The administration is mandated by president Obama[6] to present proposed regulations by June 2014, with a view have final regulations decided a year later and adopted in the states during 2016. EPA is currently engaging in a collaborative process with states, regulators, the power industry and other in order to formulate a set of regulations that can comply with the task of limiting CO2-emissions while respecting the energy models and existing climate and renewable energy regulations in different states. One possible outcome can be some sort of portfolio model that enables states to progress towards an overall emissions budget.

The proposed and upcoming EPA carbon dioxide regulations have had the coal industry and its backers react strongly, and they are branded as a war on coal[7].

In practice, however, coal also faces other challenges that in the short term may be as difficult as the above regulations. In 2011 EPA finalized the first national standards to reduce mercury and other toxic air pollution from coal and oil-fired power plants[8]. Even though the power industry will have up to four years to comply with the new regulations, it is widely recognized that it will be too costly for smaller and older coal power plants to rebuild and install the necessary scrubbers and other equipment. As an effect, it is expected that a number of small, old and inefficient coal power plants will be retired over the coming years.

[4] http://www.whitehouse.gov/share/climate-action-plan
[5] http://www2.epa.gov/carbon-pollution-standards
[6] http://www.whitehouse.gov/the-press-office/2013/06/25/presidential-memorandum-power-sector-carbon-pollution-standards
[7] http://www.gop.com/news/research/obamas-war-on-coal-is-official/
[8] http://www.epa.gov/mats/basic.html

Another regulation with potential impact on power plants, the Cross-State Air Pollution Rule (CSAPR) aimed at limiting the amounts of NOx and SO2 pollutants from the power sector that may be transported across state borders, has temporarily been stalled through court action. In the meantime, the predecessor CAIR is in effect.[9]

In addition to federal regulations, individual states' renewable energy portfolios, emissions regulations and greenhouse gas targets also work against coal, both existing and the construction of new coal power plants.

An even more powerful adversary, possibly, comes from natural gas. The low gas prices associated with the recent expansion of shale gas has led to a substantial coal to gas switch for electricity generation. Existing gas power plants have increased their production and mothballed gas turbines have been re-commissioned. When gas prices rebounded last year electricity production to some extent swung back to coal, but most observers foresee a long term switch from coal to gas and a number of natural gas power plants are currently under construction. Natural gas plants are less capital intensive than many other competing technologies, including coal. The new EPA rules that will require CCS for new coal plants coal but not for gas will make less likely that utilities choose coal over gas. The EIA estimates that gas will provide 50 per cent of new electricity generation capacity from 2011 to 2040.

The coal energy sector itself also concludes that present and up-coming regulations and other challenges give the industry a bleak domestic outlook with no or limited new construction, but argues that intensive RD&D on abatement technologies such as CCS, in particular linked with income raising techniques like enhanced oil recovery, over a couple of decades could drive down the cost of clean coal enough to make it a competitive alternative[10].

Meanwhile, the administration maintains that it is committed to securing a place in the future also for the nation's abundant fossil energy resources as part of the "all of the above"-strategy. The EPA argues, somewhat hopefully, that the power sector carbon emission rules in effect can provide the impetus that is needed to make clean coal a reality. DOE supports a number of clean coal R&D programs[11] and the Obama administration has invested an overall 6 billion USD[12] in clean coal technologies, including R&D on coal gasification, turbines, fuel cells, coal to liquids and coal to hydrogen and, in particular, a comprehensive program for CCS, see more below.

2.2 CCS

Since carbon emissions from fossil fueled power plants constitute that largest individual share of US greenhouse gas emissions, it has for a long time been recognized that CCS is an essential ingredient in any long term climate mitigation plan. The DOE has been engaged in R&D regarding all aspects of CCS since 1997[13] and through its Office of Fossil Energy it runs a number of clean coal and CCS programs[14]. Already in 2003 President Bush proposed FutureGen, a 10-year public-private partnership project to build a 275 MW coal-fired power plant that would be equipped with CCS and close to carbon neutral. The

[9] http://www.epa.gov/cair/
[10] http://www.coal.org/roadmap/
[11] http://energy.gov/fe/science-innovation/clean-coal-research
[12] http://www.netl.doe.gov/technologies/coalpower/gis/index.html
[13] http://www.netl.doe.gov/technologies/carbon_seq/overview.html
[14] http://energy.gov/fe/science-innovation/carbon-capture-and-storage-research

project has been revised a number of times over the years but is still active[15]. Legislation in 2005 and 2007 mandated the DOE to fund CCS demonstration programs and the focus of the government sponsored R&D has over the years moved towards funding large scale pilot and commercial scale projects that could prove the viability of the CCS concept.

ARRA, the financial recovery stimulus package of 2009, comprised an additional 3,4 billion USD funding for the CCS-programs and lead to considerable stepping up of efforts. The major part of the ARRA-funding was channeled to two programs; the Clean Coal Power Initiative (CCPI) that sponsored coal power plant CCS and the Industrial Carbon Capture and Storage (ICCS) that was directed at industrial CCS outside the power sector.

An initial 6 large scale power plant CCS projects were allocated 1,7 billion USD funding under the CCPI. In addition, one large scale project that received earlier funding and the FutureGen are also part of the DOE large scale power CCS projects list. Meanwhile close to 30 projects, ranging from smaller projects to three large scale integrated CCS demonstration projects received DOE funding in the ICCS program[16].

Apart from industrial CCS, the US has identified coal power plants as the major target for CCS applications. The goal of the CCS program has been to enable large scale CCS from 2020 onwards. A federal inter-agency task force set up in 2010 was charged by President Obama to come up with "a plan to overcome the barriers to the widespread, cost-effective deployment of CCS within ten years, with a goal of bringing five to ten commercial demonstration projects online by 2016"[17].

While interest and acceptance for CCS was from the outset slowly building up in industry and it seemed that the prerequisites for investing in the technology were getting in place, part of the impetus has subsequently evaporated. Of the original large scale power plant CCS demonstration projects, one is actually being built right now – the 550 MW Kemper Coal plant using pre-combustion gasification technique to capture 65 per cent of the carbon dioxide, expected to come online in 2014[18]. Four more are still on the planning stage, one of which looks likely to actually be built, while three other projects that had been granted support have been withdrawn. According to industry observers[19], there is actually the risk that none of the four planned CCS plants will commence construction until the ARRA funds run out by the end of 2015, meaning that only part of the coal plant CCS scheme is realized in the near future.

On the industrial side its looks a little better, since CCS technology in these industrial settings is typically less expensive to install and DOE has funded a higher proportion of the investment costs. Two new industry CCS demonstrations linked to enhanced oil recovery went operational in 2013.[20]

While it is recognized that there are many barriers to CCS still to overcome and many potential reasons for the diminished interest from the energy actors and investors, it is clear that the failed US climate legislation and the absence of a clear plan to introduce a carbon market or a carbon tax is a large share of the cause. Since CCS is quite costly a clear policy

[15] http://www.futuregenalliance.org/
[16] http://energy.gov/fe/fe-implementation-recovery-act
[17] http://www.whitehouse.gov/the-press-office/presidential-memorandum-a-comprehensive-federal-strategy-carbon-capture-and-storage
[18] http://www.mississippipower.com/kemper/home.asp
[19] Interview 20131210 with Howard Herzog of the MIT Energy Initiative
[20] http://sequestration.mit.edu/index.html

signal and an economic incentive to install the technology would be needed to induce the power industry to invest[21].

Still, there is a range of other aspects to take into account as well, including the complexities regarding long term storage of carbon, for CCS to be rolled out broadly.

The recently proposed EPA regulations on carbon emissions from power plants have evoked both new hope that this shall provide the needed impetus for CCS but also protests from the coal industry against regulations that require what they regard an immature (and costly) technology. The administration, and many other observers, argues that CCS is in fact ready for deployment which is shown by the full-scale plants that are already or will be on line, including both the Kemper facility and industrial applications.

It is however unlikely that the EPA rules will lead to more CCS in the short run, at least with the current low gas prices. Coal is already at a disadvantage to gas, and the need to install CCS for new plants makes it even less likely that coal would be chosen over natural gas, that according to the proposed rule does not require CCS.

It is not yet clear how the EPA's upcoming rule for carbon emissions from existing plans will be constructed, it is to be presented in June 2014. The EPA administrator has however already assured that this rule will not require the installment of CCS[22].

The current state of CCS and the related issue of regulation of power plant emissions continue to be followed and scrutinized by followers and opponents alike, including by law makers in Congress[23].

2.3 Oil

As with other fossil fuels, oil will also continue to play a decisive role for US energy over the coming years.

The US dependence on imported oil for the transport sector has been at the forefront of energy policy since the first oil crisis – virtually all presidents from Nixon onwards have vowed to end American dependence on foreign oil. While this over the years has been more of a mantra than a reality, recent developments indicate that the US can even become a net exporter of oil.

Domestic oil production has increased fast over the last years, due primarily to tight oil production using the same techniques as for shale gas. The production increased from 0.2 million barrels per day in 2000 to an estimated 2.2 million barrels per day in December 2012. Tight oil in US stands for the largest recent addition to global oil reserves. The IEA in a recent report predicted that U.S. oil production will rise to 11.6 million barrels a day in 2020, from 9.2 million in 2012, and that the US will surpass Russia and Saudi Arabia as the world's top oil producer by 2015[24].

This development is partly induced by the low gas prices – energy companies have redirected the drilling rigs to shale plays that are richer in oil and natural gas liquids, which reach higher prices on the international markets. The growth in US energy production has led to assessments that the country will become a net natural gas exporter by 2020, and that it could be "energy independent" / a net overall energy exporter by 2035.

[21] http://www.wvgazette.com/News/201308030014
[22] http://www.huffingtonpost.com/2013/09/23/carbon-capture-power-plants_n_3975848.html
[23] http://www.fas.org/sgp/crs/misc/R42496.pdf
[24] http://www.worldenergyoutlook.org/

2.4 Nuclear

US pioneered the civilian use of nuclear power in the decades following World War Two and the country remains the world's largest nuclear energy producer with currently 104 operable commercial nuclear reactors at 65 nuclear power plants. They are located in 31 states, with the majority of the reactors built in the eastern part of the US. Installed nuclear capacity plateaued after a fast build-out in the seventies. Since 1990, the share of the US total electricity supply provided by nuclear power generation has averaged about 20 per cent, with increases in nuclear generation that have roughly tracked the growth in total electricity output. Even if very large amounts of new capacity are not foreseen, nuclear energy will continue to be a substantial part of the US energy system over the medium to long term. The EIA energy outlook to 2040[25], for example, in its main scenario has electricity production from nuclear increase by 14 percent while the nuclear share of overall generation declines to 17 percent due to more rapid increases in generation from natural gas and renewables.

The future of nuclear is contingent on a number of factors. The majority of the US reactors were built in the 1970's and 80's (the average reactor age is 33 years) and the newest reactor was put in production in 1996[26]. New construction slowed down drastically in the mid 1980's and has been held back for a number of years due to the increasing cost of nuclear plants in relation to other energy sources and a number of other factors, perhaps most importantly the security issues and negative public perception of nuclear energy that followed the Three Mile Island accident in 1979 and Chernobyl in 1986.

The productive life of the reactors is now one issue in focus. US reactors are generally licensed for a 40 year life-span, with the possibility of a 20 year extension. A number of reactors have been updated and upgraded to increase generating capacity. There is also on-going research looking into the possibility for prolonging the possible life-span to 80 years. Several reactors were actually shut down in the 1990's but due to upgrades the remaining stock has increased total generating capacity.

Another issue concerns new-build. After many years of inactivity, the Energy Policy Act of 2005[27] established new policy measures to enable new nuclear plants, including production tax credits, increased support for nuclear R&D and a federal loan guarantee program. The interest in new reactors increased somewhat - at least until the Fukushima accident and the effects of the natural gas revolution were widely recognized - and currently four new reactors are under construction; the Vogtle units 3 and 4 built by Southern Company in Georgia, and the Summer units 2 and 3 built by South Carolina Electric & Gas, all expected to come online between 2016 and 2017[28]. The permitting of Vogtle 3 and 4 in 2012 was the first construction permit granted in over 30 years. But the high costs of building new nuclear put limits on further expansion. The reactors that are under construction were planned before current low priced gas made its mark on the energy sector. Further, the plants are built by utilities in electricity markets that are still fully regulated. In the case of the Vogtle plant, the operator was permitted by the regulating authority to recuperate production costs from the ratepayers even during the construction period, before the plant is operational. A commercial power generator working on a deregulated market could not enjoy such benefits.

[25] http://www.eia.gov/forecasts/aeo/
[26] http://www.eia.gov/energy_in_brief/article/nuclear_industry.cfm
[27] http://www.gpo.gov/fdsys/pkg/PLAW-109publ58/pdf/PLAW-109publ58.pdf
[28] http://www.nrc.gov/reactors/new-reactors/col-holder.html

Still, the Nuclear Regulatory Commission (NRC) currently has active applications for an additional 28 new reactors. While it is not known how many of the proposed reactors will actually be built, official energy outlooks do not count on any significant construction activity. Meanwhile the DOE and several of the National labs continue to perform and fund R&D for nuclear energy, including small, modular reactors and other new generation designs[29].

One contentious issue concerns long term nuclear waste storage. Even though the need to establish a long term solution for waste management including how and where to store nuclear waste has been recognized for decades, the US has to date failed to implement a waste disposal plan. Nuclear waste is currently stored at a large number of reactor sites in the wait for a more permanent solution.

After years of intensive studies to evaluate and determine the suitability of different long term depository alternatives, Congress decided in 1987 to mandate the building of the US spent fuel and high-level nuclear waste repository beneath the Yucca Mountain in Nevada.

The decision was highly contested by the state of Nevada, environmental organizations and other parties, and the process of going forward with the necessary planning and permitting proved difficult. The DOE, however, in the last year of the Bush Administration filed an application for authorization of construction of the storage with the NRC.

The Obama administration, supported by Senate majority leader Harry Reid (D-Nevada), stopped the process when it in 2010 determined that Yucca Mountain was not a workable option and ordered the NRC to terminate its reviewing of the DOE application. To start the process all over and identify a way forward President Obama instead ordered the DOE to convene a high level committee to review and propose nuclear waste storage policy. The Blue Ribbon Committee on America's Nuclear Future delivered its final report in 2012[30], with recommendations that include developing a new process to site disposal and consolidated storage facilities (the Swedish collaborative and consent based process for nuclear waste siting is noted in the report); initiating the search for a new geologic disposal facility; establishing consolidated interim storage locations to remove used fuel from reactor sites; reorganizing how the government performs these functions and how they are financed; and continued exploration for improved technologies for waste management.

Yucca Mountain has proved not to be fully out of the picture, however. Under the pressure from states and power plant operators that require prompt storage options and the threat of substantial economic penalties for the federal administration for non-delivery of contractual obligations to provide storage, several petitions have been filed to contest the administration's decision to abandon the project and in August 2013 the Washington DC Court of Appeals ordered the NRC to continue the permitting process[31]. The issue is now partly tied to the federal budget and the appropriations of funds for the permitting process.

[29] http://www.world-nuclear.org/info/Country-Profiles/Countries-T-Z/USA--Nuclear-Power-Policy/

[30] http://cybercemetery.unt.edu/archive/brc/20120620220235/http://brc.gov/sites/default/files/documents/brc_finalreport_jan2012.pdf

[31] http://www.atg.wa.gov/uploadedFiles/Home/About_the_Office/Cases/Yucca/Opinion.pdf

2.5 Renewables

Hydropower at the present provides the bulk of the renewable energy capacity, with 100 GW installed power. But the growth in renewable generation capacity lately has ocurred in other sectors, predominantly solar and wind, and installed capacity for renewables excluding hydro doubled between 2008 and 2013. Wind stands for the largest part of added capacity in absolute terms. The large influx of windcapacity in 2012 was partly due to the anticipated expiration of the Production Tax Credit (PTC). Solar has grown quickly, albeit from a low level (solar energy comprised less than 0,2 per cent of final energy consumption in 2011), following sharply falling prices on PV modules. Consumption of biofuels, in particular ethanol for blending in gasoline, has also grown rapidly over the last ten years to substantial levels. Hydropower generation made up 35 per cent of the consumption of renewable energy in 2011, with other renewables contributing shares down to 2 per cent for solar PV.

President Obama has set the goal of doubling renewable energy again to 2020.

At the federal level tax credits, other tax benefits and stimulus programs form one of the main instruments for supporting renewable energy. One of the most important instruments is the PTC which has been used to subsidize sectors such as wind, biomass, geothermal, and hydropower. The PTC provides tax incentives between 11 and 22 USD/MWh for eligible investments, and has been a major driver for e.g. the expansion of wind power. The PTC was set to expire by the end of 2012 but has been prolonged and modified for 2013. A possible further extension is discussed in relation to the present budget talks but seems unlikely at the moment.

The Investment Tax Credit (ITC) allows project developers to take a tax credit equal to 30 per cent of the cost of constructing their project. The solar industry has been the primary beneficiary of this incentive. The ITC will be in place through the end of 2013 for wind, biomass, geothermal, hydropower, marine and tidal energy, and through 2016 for solar, fuel cells, and small scale wind.

Under the federal Modified Accelerated Cost-Recovery System (MACRS), businesses may recover investments in certain property through depreciation deductions.

For all renewables Accelerated Depreciation Accounting is allowed to reduce tax bills as well.

The above instruments are primarily useful to companies that have sufficient income tax to offset. Renewable energy developers that do not have sufficient income streams can attract investment from so called tax equity investors, actors unrelated to the industry that seek tax reductions, and pass through the tax credit.

Tax incentive	Incentive	Sector	Expiration
Investment Tax Credit	Credit equal to 30% of eligible capital expenditure	Solar, fuel cells, small wind	Must commission by end-2016 for 30% incentive (10% incentive thereafter, without expiration)
		Wind, biomass, geothermal, hydropower, marine, tidal	End-2013
	Credit equal to 10% of eligible capital expenditure	Geothermal	No expiration
		CHP	End-2016
Production Tax Credit	Ten-year production-based credit equal to $22/MWh (inflation adjusted)	Wind, closed-loop biomass, geothermal, solar	Must 'begin construction' by end-2013
	10-year production-based credit equal to $11/MWh (inflation adjusted)	Open-loop biomass, landfill gas, trash combustion, marine, qualified hydropower and hydrokinetic	Must 'begin construction' by end-2013
MACRS	Allows tangible property to be depreciated on an accelerated basis (wind, solar and geothermal are depreciated as five-year property and biomass as seven-year property)	All sectors	Superbonus depreciation (100% in year one) expired at end-2011; bonus depreciation (50% in year one) expires in end-2013. MACRS does not expire.

Source: Bloomberg New Energy Finance Note: Small wind refers to projects 100kW or less. MACRs stands for Modified Accelerated Cost Recovery System.

Figure 2 Federal Tax Incentives for Sustainable Energy[32]

Also at the federal level, the Renewable Fuel Standard (RFS) that requires low scale blending in of alternative fuels to gasoline has been absolutely fundamental in driving the massive expansion of biofuels over the last ten years, in particular corn ethanol. (The other driver for corn ethanol has been the prohibition of MTBE oxygenates). The RFS-rules were updated by the Environmental Protection Agency in 2010, RFS2, limiting the amount of corn ethanol that can be used to fulfill the standard and demanding increasing amounts of second-generation cellulosic alcohol. The rulemaking is contested by both the oil industry and other lobbying groups, partly because a stagnant fuel market has put a limit to the amounts of ethanol that can be blended. As a consequence, The EPA has recently proposed to scale down the RFS requirements for 2013.

At the state level, one of the most important instruments for supporting renewable energy has been Renewable Portfolio Standards (RPS). Currently, 30 states and the District of Columbia have enforceable RPS regulations. The design of the standards differ between states, but they typically set levels of renewable electricity generation that utilities are required to achieve and can be accompanied by non-compliance penalties, trading schemes and other ingredients. Calculations indicate that RPS targets for 2025 will amount to about 10 per cent of U.S. electricity sales. At present most states are meeting or even exceeding their required levels of renewable generation, which means that the RPS, if the requirements are not sharpened, will lose some of their driving force.

Apart from the RPS, there are many other state and local support programs and requirements that impact renewable energy, ranging from green building incentives and building codes over energy standards, loan programs and tax incentives to net metering

[32] Sustainable Energy in America Factbook 2013. Bloomberg Finance and the Business Council for Sustainable Energy

requirements. (For a comprehensive overview over financial incentives and other regulations, see DSIRE, Database of State Incentives for Renewables & Efficiency.)

Apart from the different tax incentives and subsidies, the federal R&D budget is to a large extent devoted to supporting research, development and deployment of renewables and other clean energy, through the Loan Guarantees Program, the ARPA-E innovation agency and the many other R&D support program that are run by DOE as well as other departments.

Looking ahead, the EIA scenario for renewables up to 2040 describes a continuing major build out of solar and wind electricity generating capacity, but also biomass and geothermal electricity will increase substantially. By 2040, EIA reckons that renewables account for nearly one-fifth of total electricity generating capacity, with total growth of non-hydro capacity by 150 per cent compared to 2011. Solar will lead the development, increasing by more than 1000 per cent or 46 Gigawatts, with wind expansion following closely with an additional 42 Gigawatts. Wind will be larger than hydro in terms of installed capacity by 2040. At a much lower level, biomass capacity is still expected to double over the period, and geothermal triple. The growth in renewables occurs primarily in the period up to 2016, by which a number of the significant tax credits have ended, and from 2030, as renewables are then expected to have become cost competitive with natural gas and other competitors.

Renewable electricity generation is projected to grow by an annual rate of 1,6 per cent over the period to 2014, mainly due to growth rates in solar generation (8,6%/year), biomass (4,5%/year) and wind (2,6% per year). Hydro, with no growth at all, will still make the largest contribution due to high capacity utilization compared to wind and solar.[33]

2.6 Energy efficiency

Energy efficiency is identified as an important policy field and as a vehicle for achieving overarching goals of energy independency, economic growth and job creation and environmental protection, in particular as regards reducing greenhouse gas emissions. Energy efficiency is by many presented as a cost efficient no-regrets policy, or as a win-win-win policy as it is put by Jeanne Shaheen, a Senator currently pushing for new energy efficiency bipartisan legislation together with Rob Portman[34]. Even though energy efficiency measures have been in place since the seventies there is still ample room for more energy conservation in the US economy. The Quadrennial Technology Review reported that the country could reduce energy consumption by up to 30 Quads[35] by 2030 by implementing cost efficient energy saving energy technologies.

Energy efficiency policy measures are being developed and implemented at federal, state and local levels and in different parts of the economy.

One vocal advocate and campaigner over the last couple of years has been the Alliance to Save Energy (ASE)[36]. ASE is a non-profit coalition of energy businesses, utilities, local government, environmental and consumer leaders that was founded in 1977. In 2012 ASE created a new commission to look into the potential for additional national energy efficiency policy, partly as a response to the economic slowdown following the financial

[33] http://www.eia.gov/forecasts/aeo/index.cfm
[34] http://www.shaheen.senate.gov/imo/media/doc/Shaheen-Portman_One%20Page_Summary_113th.pdf
[35] A quad is a unit of energy equal to 10^{15} BTU or 1.055×10^{18} joules
[36] http://www.ase.org/

crisis. Through the work of a number of sub-committees and extensive consulting with different stakeholders a comprehensive set of policy recommendations with a view to doubling energy productivity by 2030 were put forward[37]. ASE argues that this 2030 efficiency goal would lead to annual savings of 327 billion USD and 1.3 million jobs added.

President Obama has touched upon energy efficiency at several occasions and the administration had put forward a number of energy efficiency schemes. In the budget proposal for 2014 Obama included the ASE goal of doubling energy productivity by 2030 (*doubling the economic output per unit of energy consumed in the United States by 2030, relative to 2010 levels*) and it is now part of the President's overarching energy goals, along with goals for increasing renewable energy use, diminishing oil imports and limiting greenhouse gas emissions.

The President's June 2014 climate plan and ensuing Executive Orders also presented energy efficiency measures, including expanding an existing initiative to partner with industry and house owners to make buildings 20 per cent more energy efficient by 2020, energy intensity goals for federal buildings and new and strengthened standards for appliances (estimated to lead to 3 billion tons of yearly carbon dioxide reductions by 2020) as well as fuel efficiency standards for heavy duty vehicles.

Some of these measures actually go back to earlier administrations. The Energy Independence and Security Act of 2007 for example, that was signed in to law by President Bush, set comprehensive energy-management requirements including energy-intensity reduction goals for federal buildings, set standards for energy-savings performance contracts and introduced federal agency annual reporting guidelines, among other things.

The Department of Energy (DOE) and other parts of the administration have important roles in in putting in place energy efficiency measures.

In the case of DOE, supporting R&D for increased energy efficiency and developing and in particular implementing energy efficiency standards including the ones mentioned above are two important domains. Over the past four month alone DOE has proposed five new efficiency regulations, including revised standards for commercial refrigeration units, walk-in coolers and freezers, lamp fixtures and furnace fans as well as new standards for commercial and industrial electric motors. Energy conservation standards now apply for more than 50 categories of appliances and equipment. As a result of the standards, energy users according to DOE saved about 40 billion USD on their utility bills in 2010. DOE estimates that cumulative operating cost savings from all standards are estimated to reach 1.7 trillion USD by 2030, with a reduction of 6.5 billion tons of carbon dioxide emissions. Products covered by standards represent about 90 per cent of home energy use, 60 per cent of commercial building use, and 29 per cent of industrial energy use[38].

In the case of building standards, which are not regulated at the federal level, DOE develops and implements model codes and standards. DOE also provides technical assistance to states and localities as they adopt and enforce energy codes.[39]

DOE further assists in developing the vehicle fuel standards, Corporate Average Fuel Economy Standards (CAFE), that are established by the National Highway Traffic Safety

[37] http://www.ase.org/policy/energy2030
[38] https://www1.eere.energy.gov/buildings/appliance_standards/
[39] http://www.energycodes.gov/about-building-energy-codes

Administration (NHTSA) and the Environmental Protection Agency (EPA). The latest CAFE version from 2012[40][41], effective through 2025, will increase vehicle efficiency to an average of approximately 160 g of CO2 and 50 miles per gallon, by 2025. EPA estimates that the standards over the period 2012-2025 will decrease oil consumption by an overall 12 billion barrels and lead to savings of 1.7 trillion USD and CO2 reductions of 6 billion tons[42].

The EPA also since 1992 runs ENERGY STAR[43], a voluntary labeling program for appliances and buildings designed to identify and promote energy-efficient products to reduce greenhouse gas emissions.

The Department of Defense, DoD, the world's largest user of fossil energy, is also very active regarding energy efficiency polices for both economic and security/operational reasons. Increased energy efficiency in different parts of the military machinery would lead not only to a lowered energy bill but also to operational security. Substantial resources and personnel are deployed to energy support lines to troops in for example Afghanistan, and a high number of casualties are associated with energy supply.

(The drivers for focusing energy efficiency at the national/federal level are thus centered round economic efficiency and savings, economic growth, industrial competitiveness and job creation, lowering of greenhouse gas emissions, diminished energy dependency and increased security.)

Energy efficiency is also, or rather even more promoted at the state and local levels. The American Council for an Energy-Efficient Economy (ACEEE), a non-profit organization, keeps track of and ranks states' and local communities' energy efficiency policies and activities. Connecticut, Massachusetts and California are some of the states that top the rankings.

As with many other energy and sustainability issues, California has been a leader in energy efficiency since the 1970's. It was the first state to adopt appliance and equipment efficiency standards, many of which have subsequently become federal standards.

California has enacted ambitious legislation that drives energy efficiency, renewable energy and reduction of greenhouse gas emissions. As one example, the state "loading order" prioritizes cost-efficient energy efficiency measures over developing new power.

Much of California's, and typically also other states' work on energy efficiency is being done through the utilities. Investor owned utilities (IOU's) that are regulated by the California Public Utilities Commission (CPUC) administer a number of mandatory energy efficiency programs directed at customers and end users. Goals for yearly energy savings have been developed jointly by the state and the IOUs and have subsequently been codified. Electricity and gas rates as well as provisions for R&D spending are regulated by the CPUC. In order to incentivize IOU's for energy efficiency measures California has carried out *decoupling*, whereby utilities' income is separated from sales volumes through different formula. Decoupling is combined with performance incentives for meeting or

[40] 75 Federal Register 25324, May 7, 2010
[41] 77 Federal Register 62624, October 15, 2012
[42] http://www.epa.gov/fueleconomy/fetrends/1975-2012/420s13001.pdf
[43] http://www.energystar.gov/index.cfm

exceeding energy efficiency targets[44]. Mandatory, yearly energy efficiency targets for utilities are today found in a number of states.

Partly due to the energy efficiency programs California has been able to hold a constant per capita electricity use over the last 30 years, while the use for the US as a whole has increased substantially and the state is often presented as an example. There are however also other opinions on this. Professor Levinson at the Georgetown University argues that other factors, notably US migration to southern states that demand more cooling, the mild California climate and relatively larger households in California explain much of the differences[45].

At the local level a long range of cities and local administrations are driving quite ambitious energy efficiency programs.

Energy savings performance contracts (ESPCs) is an increasingly popular method for energy efficiency projects, both in the private and public sector. In the US, as in Sweden, even cost efficient/profitable energy efficiency measures can be hindered by financing problems. The ESPC model means that an energy service company (ESCO) is contracted to develop, install, and fund projects designed to improve energy efficiency and reduce operation and maintenance costs for the customer's facilities. The ESCO guarantees that the improvements will generate energy cost savings enough to pay for the project. The method makes it possible for government agencies and private actors to carry out energy efficiency projects without having to finance the upfront investment. DOE certifies ESCO's that can engage in federal government agency procurement.

Energy Performance Contracting (EPC) is an innovative financing technique that uses cost savings from reduced energy consumption to repay the cost of installing energy conservation measures. Normally offered by Energy Service Companies (ESCOs), this innovative financing technique allows building users to achieve energy savings without upfront capital expenses. The costs of the energy improvements are borne by the performance contractor and paid back out of the energy savings. Other stated advantages include the ability to use a single contractor to do necessary energy audits and retrofit and to guarantee the energy savings from a selected series of conservation measures.

[44] http://aceee.org/sector/state-policy/california
[45] http://www9.georgetown.edu/faculty/aml6/pdfs&zips/CaliforniaEnergy.pdf

3 Governance of the energy system

Which principles and methods for governance of the energy system are then used in the US setting? A discussion of these issues merits a couple of initial overall observations.

First, energy infrastructure in the US is primarily is primarily owned and operated by the private sector. The oil, coal and gas industries, including refineries, pipelines and other infrastructure are in principle 100 per cent privately owned and operated. The structure of the electricity industry is more complex and fragmented, but investor owned utilities account for more than two thirds of retail electricity sales and many of them are vertically integrated and own transmission and distribution lines in addition to 60 per cent of electricity generating capacity. Individual, privately owned power producers answer for an additional 30 per cent of generation. A long range of government regulations at different levels, tax codes, incentives and other interventions influence the energy markets but the government will continue to be dependent on the private sector for the transformation of the energy sector and for large scale investment in renewables and clean technologies.

Second, not only the federal level but also the states and local governments have important roles in governing the energy system. The federal level sets overall policies, principles and regulations, provides economic incentives through the tax system and other instruments and provides facilities and funding for research and development, but states are as, or sometimes more important, for setting policies that drive the development. In addition, many actors apart from the DOE have decisive roles for energy policy at the federal level and there is not, yet, a tradition of setting comprehensive energy policies.

In addition, energy and environment policy has become a partisan and divisive issue at the federal level and in Congress, in particular in relation to climate change.

The above results in a complex and layered policy arena. A number of the most important policy instruments are discussed below.

3.1 Emissions trading/carbon pricing

An initial word on the policy that is *not* in place is warranted; The Obama administration and the more climate action oriented states and cities would like to see climate legislation passed to guide the transition of the energy system towards overall climate goals by putting a price and/or cap on emissions. Since the proposed Cap-and-trade legislation of a few years ago died in Congress in 2010 it is however clear that the US will not have a climate legislation in the near future. The concept of a carbon tax surfaces every now and then in policy debates but the chances of a tax actually being introduced are regarded as slim, to say the least.

Two other carbon trading schemes do exist in US today: the California cap and trade system that was introduced last year as part of the state's climate legislation AB 32[46], and the Regional Greenhouse Gas Initiative[47], a program set up by nine states to (loosely) cap and reduce carbon emissions from the power sector. The US also has a cap and trade system in place for SO2 and NOx emissions since 1995[48].

[46] http://www.arb.ca.gov/cc/capandtrade/capandtrade.htm
[47] http://www.rggi.org/
[48] http://www.epa.gov/airmarkt/progsregs/arp/basic.html

But the absence of federal climate legislation and a price on carbon – or some other policy instrument that strongly influences the energy markets - severely limits the effects of energy policy directed at limiting greenhouse-gas emissions.

3.2 Regulations and standards

Absent comprehensive climate legislation, the administration is working through other, existing legislation to implement climate policy and drive energy system change, while at the same time addressing other types of pollution and drive energy efficiency and economic development.

The EPA's work on limiting carbon dioxide emissions from power plants through the Clean Air Act described above is the centerpiece of President Obama's climate strategy, but other regulations including the MATS regulations on mercury emissions from power plants may be as effective.

Other environmental regulation, both at the federal and state levels, regarding a long range of issues such as standards and minimum requirements for methane capture in association with shale gas development impacts significantly on the energy sector.

CAFE, the fuel economy standards issued by the Federal Highway Administration and EPA that the auto industry must comply is another central regulation that aims at pushing for energy efficiency and decreased greenhouse-gas emissions in the auto sector. CAFE will be followed by emissions standards for heavy duty vehicles.

As mentioned earlier, energy efficiency standards directed at appliances and electrical equipment issued by DOE is another method used.

The Renewable Fuel Standard that requires blending of renewables in fossil transport fuels has been decisive in driving the US corn ethanol industry, while effects on second and third generation fuels so far are much smaller. The RFS is hotly debated and opposed by the oil industry, and the EPA recently proposed a scaling down of ethanol volumes for the coming years due to saturation of the fuel market.

Regulatory measures and standards are also used extensively at the state and levels.

Renewable Portfolio Standards (RPS) that typically require a certain amount renewable electricity generation are one of the main instruments at the state level. To date more than 30 states have introduced an RPS. Several states and cities have also decided upon carbon emission reduction targets. (President Obama has in fact proposed a *national* clean energy standard, to complement states RPS, but this element has not been realized as it would require new legislation.)

States also to a higher or lesser degree regulate the electricity and gas markets directly through the regulatory public utility commissions. A typical example would be that a public utility commission requires investor owned utilities to achieve a certain amount of customer energy savings each year. Such a measure may be linked with some sort of decoupling of the utilities' income from sales volumes. Utilities are also regulated in other ways, including requirements to fund energy research. States and local level government also use building regulations to drive energy efficiency.

California, a frontrunner in environmental regulation, has introduced several other policy measures. Apart from the climate legislation mentioned above the state also has for

example a low carbon fuel standard[49] that requires a reduction of at least 10 per cent in fuel carbon intensity by 2020.

3.3 Tax incentives, subsidies, information

Tax incentives have been important in influencing the development of the energy system. Fossil fuels have received substantial subsidies historically and still enjoy different types of tax incentives. Also the development of renewables depends heavily on tax breaks. Tax incentives for clean energy development over the last years have amounted to between 7 and 10 billion dollars yearly.

One of the most important instruments is the Production Tax Credit (PTC) which has been used to subsidize sectors such as wind, biomass, geothermal, and hydropower. The PTC provides tax incentives between 11 and 22 USD/MWh for eligible investments, and has been a major driver for e.g. the expansion of wind power. The PTC was set to expire by the end of 2012 but has been prolonged and modified for 2013.

The Investment Tax Credit (ITC) allows project developers to take a tax credit equal to 30% of the cost of constructing their project. The solar industry has been the primary beneficiary of this incentive. The ITC will be in place through the end of 2013 for wind, biomass, geothermal, hydropower, marine and tidal energy, and through 2016 for solar, fuel cells, and small wind. An array of other tax instruments exists in parallel with the above.

The recurring sun-setting and renewal of some of these instruments have led to low predictability and adverse effects on investment. With the 2014 budget currently under discussion it is uncertain whether the PTC will be prolonged immediately, but tax instruments will continue to be an important instrument for energy policy.

Apart from the tax subsidies there are a number of support programs for renewable energy and energy efficiency, administered by DOE and other departments. DOE also hosts a variety of information and advice structures, including for example the Better Buildings Challenge that supports commercial and industrial building owners by providing technical assistance on energy efficiency.[50]

The individual states also offer different tax and other incentives programs[51].

3.4 Permitting

Vast arrays of land and the continental shelves that are publicly owned and controlled by the federal government are important for energy production, both as concerns oil and gas as well as for renewable energy. Hence the Department of the Interior and other responsible agencies' issuing of permits and leases to the private sector for energy exploration and production is of great importance and President Obama has vowed permitting of an additional 10 Gigawatts of renewables by 2020.

[49] http://www.arb.ca.gov/fuels/lcfs/lcfs.htm
[50] http://www4.eere.energy.gov/challenge/home
[51] For an overview see http://www.dsireusa.org

3.5 Research and Innovation

Apart from regulation, tax incentives and subsidies, energy R&I support, with the DOE as the main federal actor, continues to be one of the most important policy fields for transferring to a low carbon sustainable energy system. The DOE yearly budget for R&I is approximately 4 billion USD. It is directed to basic and applied research for all energy fields including nuclear and clean coal. President Obama has presented a significantly increased energy R&I budget proposal, including new measures as an energy security trust fund financed by oil and gas royalties, but it is not likely that many of the new initiatives and budget increases will be part of any budget agreement that comes out of the Congress in the upcoming few months. For an in-depth description, see the recent Growth Analysis report on energy R&I.

3.6 Integrated policy

Finally, a long range of different organizations and forums for advising and guiding policymaking is an important part of the policy measures used. This includes institutions as the President's Council of Advisors on Science and Technology (PCAST), advisory boards and panels in DOE and other departments and other functions. The recent decision to perform a Quadrennial Energy Review is intended engage and align the most important federal energy actors to achieve more integrated and effective energy policy.